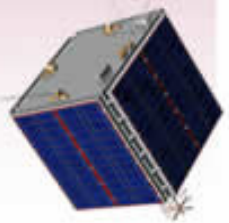
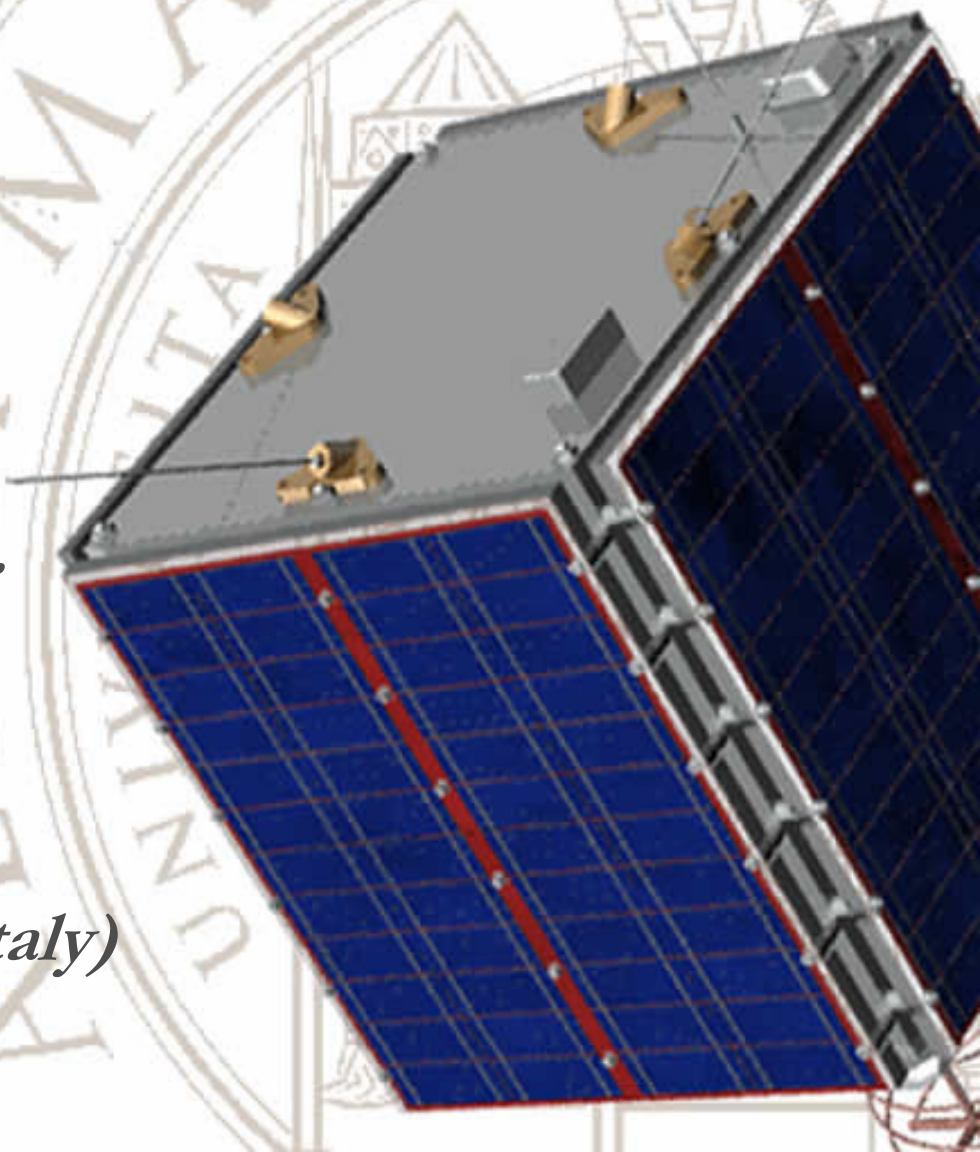
ALMASat Alma Mater Satellite

ALMASat Microsatellite

Platform for Small Scientific Experiments in Orbit





Giulio Pezzi IZ4FVW - AB2VY

RF Engineer

Team collaborator of :

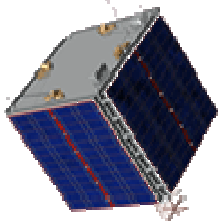
II School of Aerospace Engineering

University of Bologna

Via Fontanelle 40, Forlì (Italy)

iz4fvw@iz4fvw.net

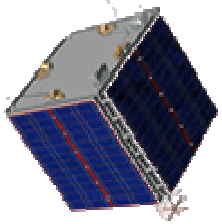
ALma MAter Satellite



Summary:

- ALMASat Laboratory
- The Microsatellite Program in Forlì
- The Forlì Ground Station
- ALMAtraker
- S-Band subsystem tests
- ALMASat-1 Microsatellite
- Conclusions

ALMASat Alma Mater Satellite

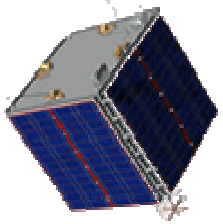


Main research and educational buildings

Microsatellite Laboratory

Available facilities

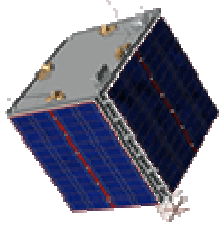
- A VHF/UHF/S amateur ground station;
- Digital electronics prototyping (PC, power supplies, oscilloscope, function generator @ 15MHz, JTAG emulator for Atmel® AVR microcontrollers;
- RF prototyping (at VHF, UHF and S bands);
- A test bench for the experimental validation of micropropulsion systems, a 15l, 200 bar, Nitrogen tank, pressure regulators, micro-valves, digital and analogue manometers and data acquisition systems;



- A glove box (100x100x150 cm) for solar panels assembly and integration;
- A Hardware-In-the-Loop (HIL) simulation test bench;
- A momentum/reaction wheels test platform
- A rotating platform for calibration of attitude sensors (accuracy of 1/100 of a degree)
- A temperature-controlled vacuum chamber (20°-150°), vacuum level ~10^{-2} mbar

The microsatellite program in Forlì

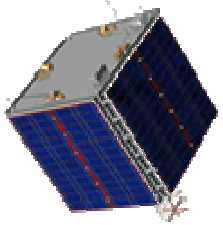
- Design, assembly and set-up of an **amateur radio station** → **fully operational**
- Design and assembly of a **Multi-mission satellite platform,** modular configuration
- Launch of the first microsatellite prototype, **Alma Mater Satellite - ALMASat** (in the second half of 2008)



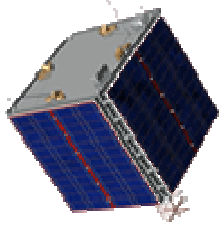
ALMASat Alma Mater Satellite

The Alma Mater Ground Station (AMGS)

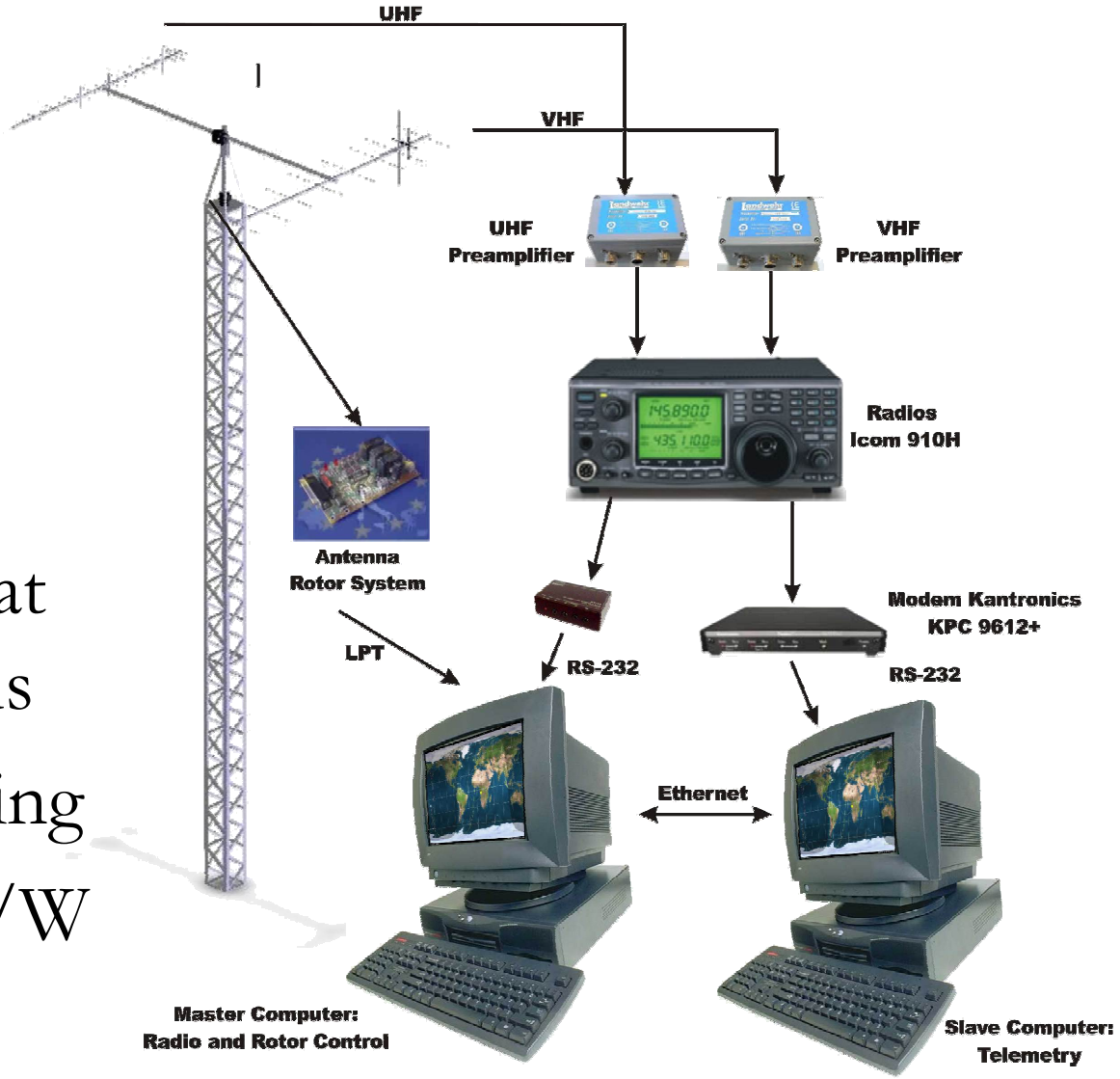
- **2003:**
  - ***Design e setup of the ground station***
    - External mast, rotors, UHF and VHF antennas
    - Hardware assembly for station control and signal RX
    - Commercial software
- **2005:**
  - ***S-band downlink channel implementation***
    - Installation of an integrated receiving system
    - Hardware updates
    - New S/W for station control simultaneous RX in multiple bands
- **2006:**
  - ***Design and implementation of a new electronic board for rotor control***
    - Software updates



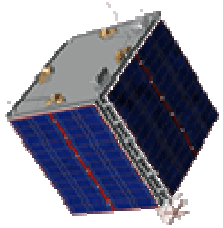
AMGS in 2003 (1/2)

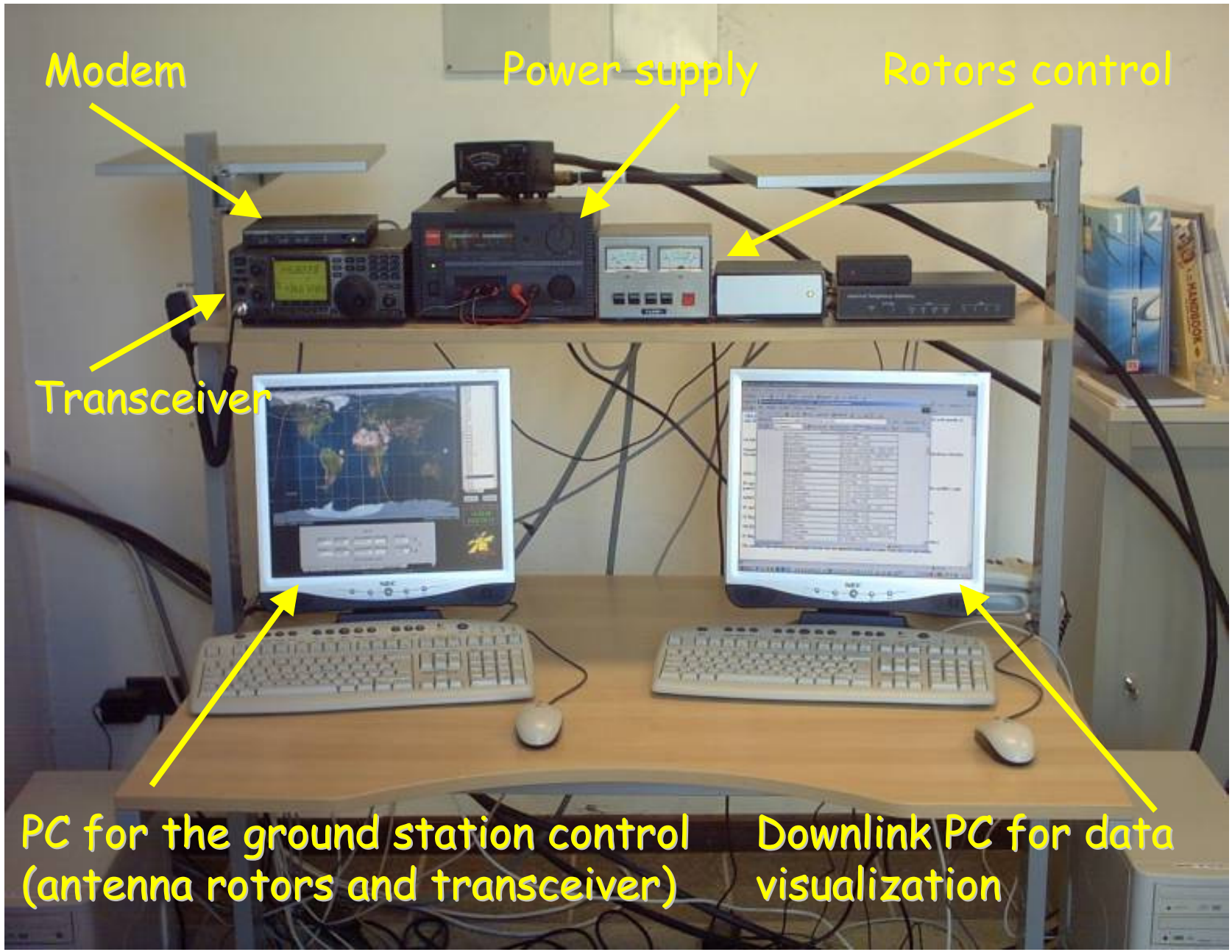


- C.O.T.S.
- Communication at UHF/VHF bands
- Automated tracking
- 3 management S/W



AMGS in 2003 (2/2)





AMGS in 2005

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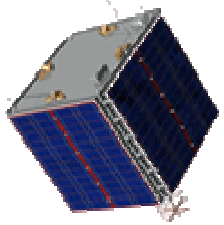
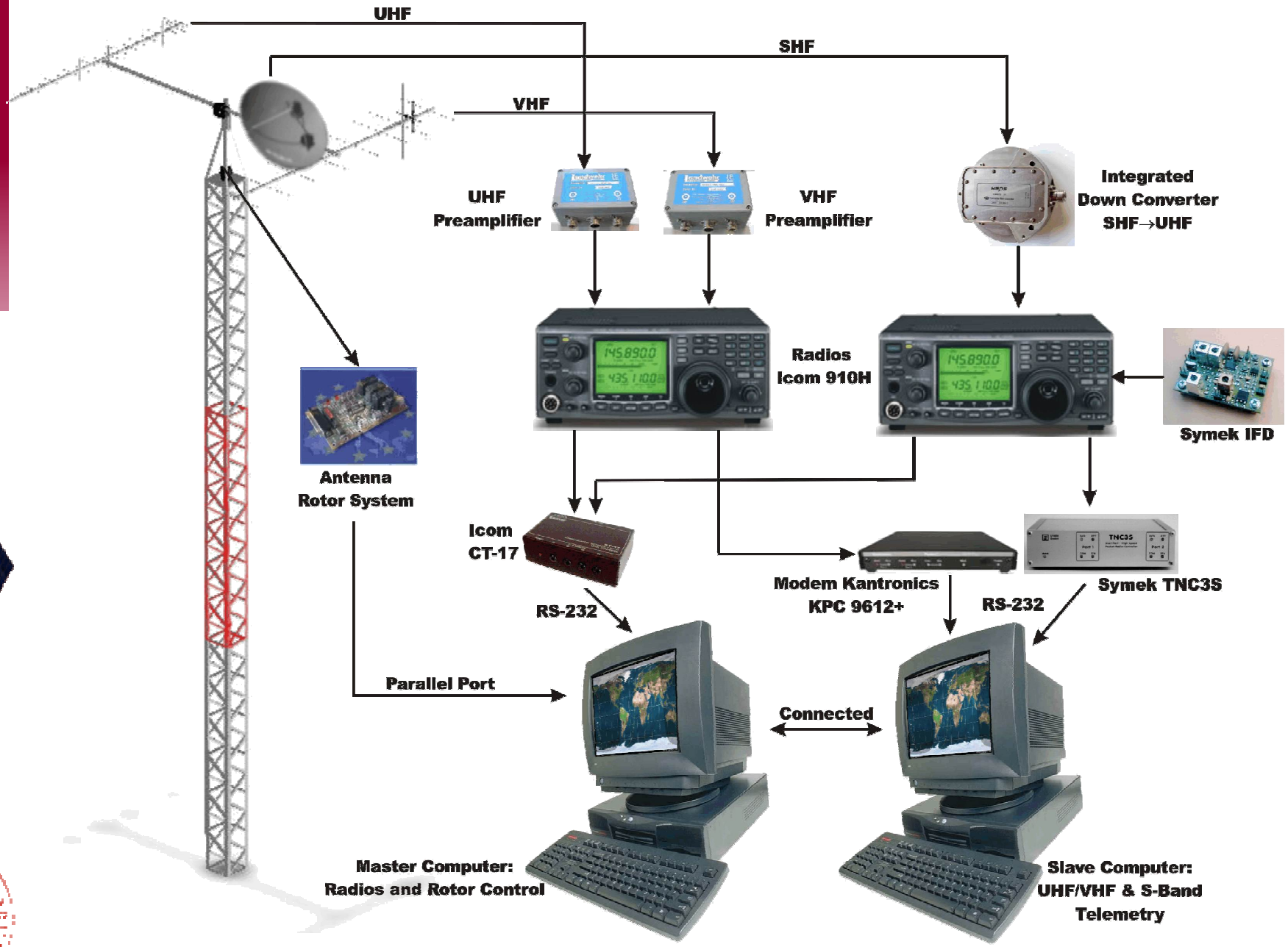
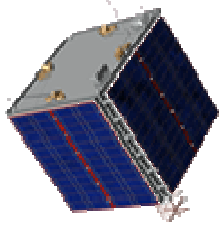




External instrumentation upgrade in 2005

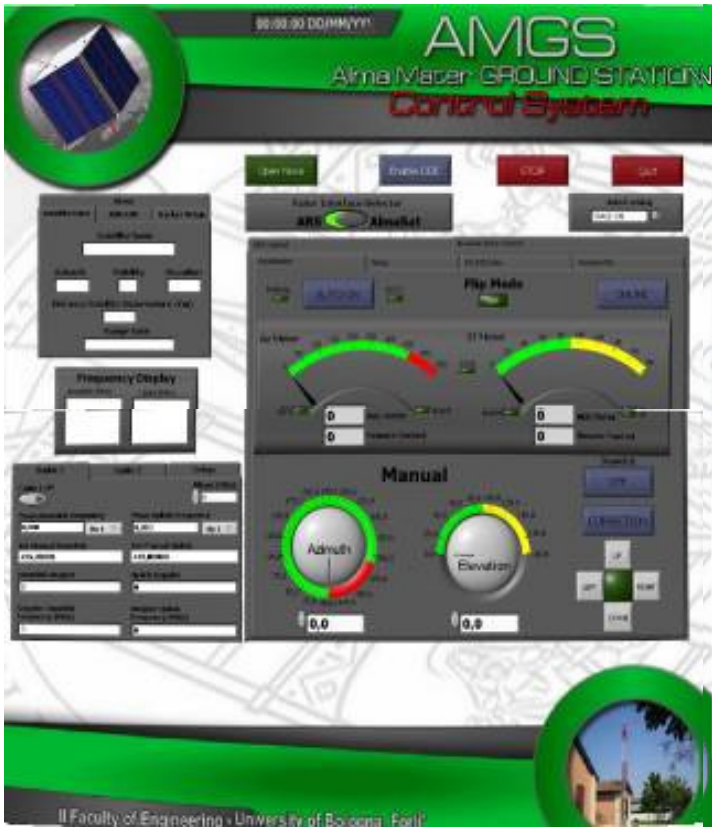
Technical characteristics:

- Polarization: RHCP
- Diameter: 70 cm
- λ: 0.245
- f/D: 0.35
- Mast diameter: ø 40 - 60 mm
- Input frequency: 2407-2409 MHz
- Output frequency: 437-439 MHz
- Gain: 36 dB
- Noise figure: typ. 0.9 dB
- Operational voltages: 11 - 15 V

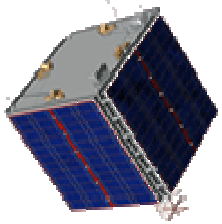


- **Down-converter and mast support assembly**
- **Positioning at 50 cm from vertical mast to avoid misalignments**

S/W upgrades in 2006



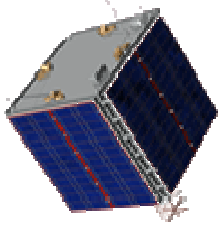
S/W upgrades for the new rotor control system



- **Ready for Voice and Data S-band reception of AO-51 and other satellite**

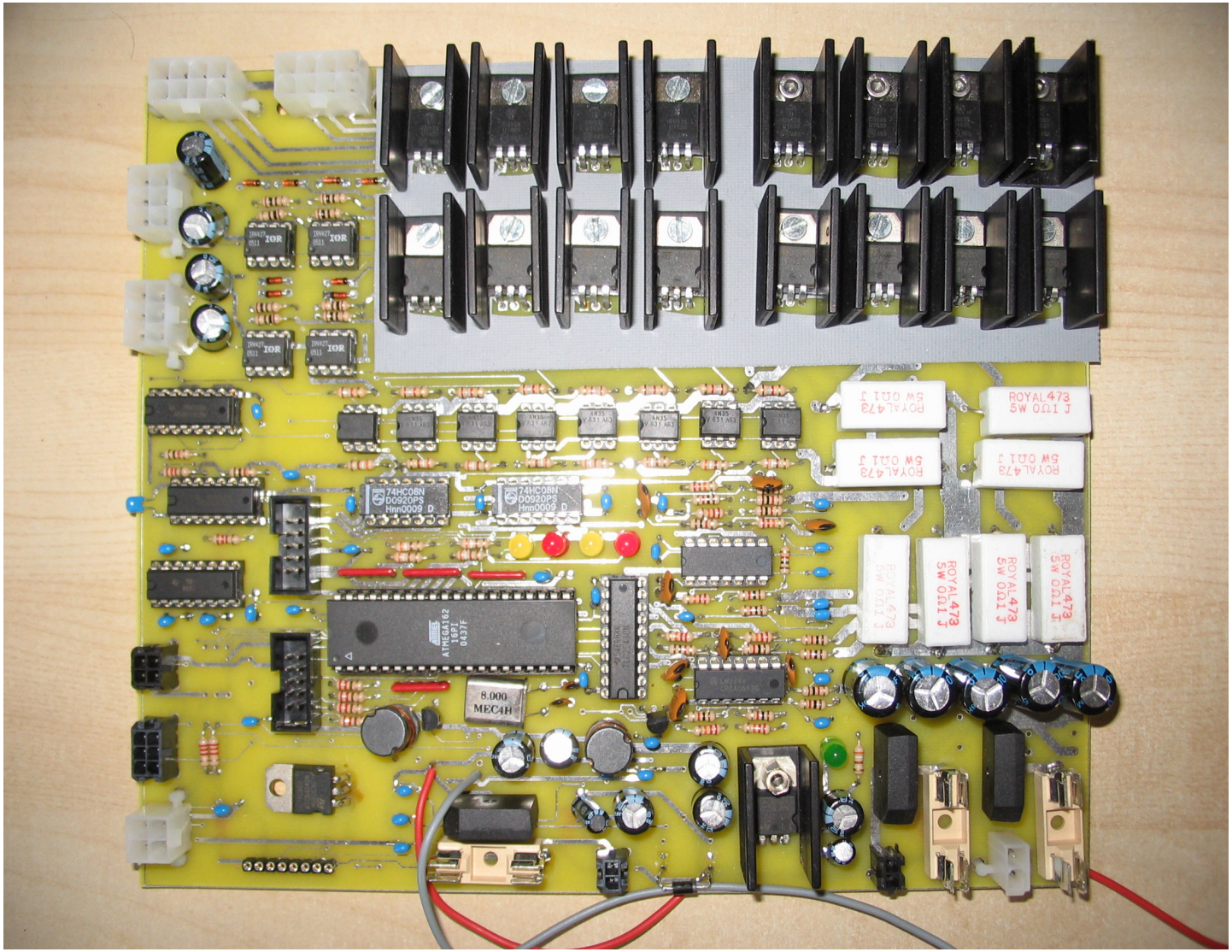
AlmaTracker

High precision (~0.01°) tracking system for satellite ground stations



AlmaTracker

Prototype of control board for AlmaTracker



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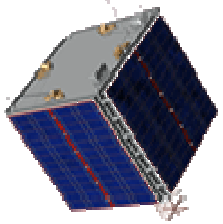
S-Band satellite subsystem

- Modulator CX72302 Dual Fractional-N Frequency Synthesizer
- 2407 Mhz RF Power Amplifier
- Quadrifilar Antenna

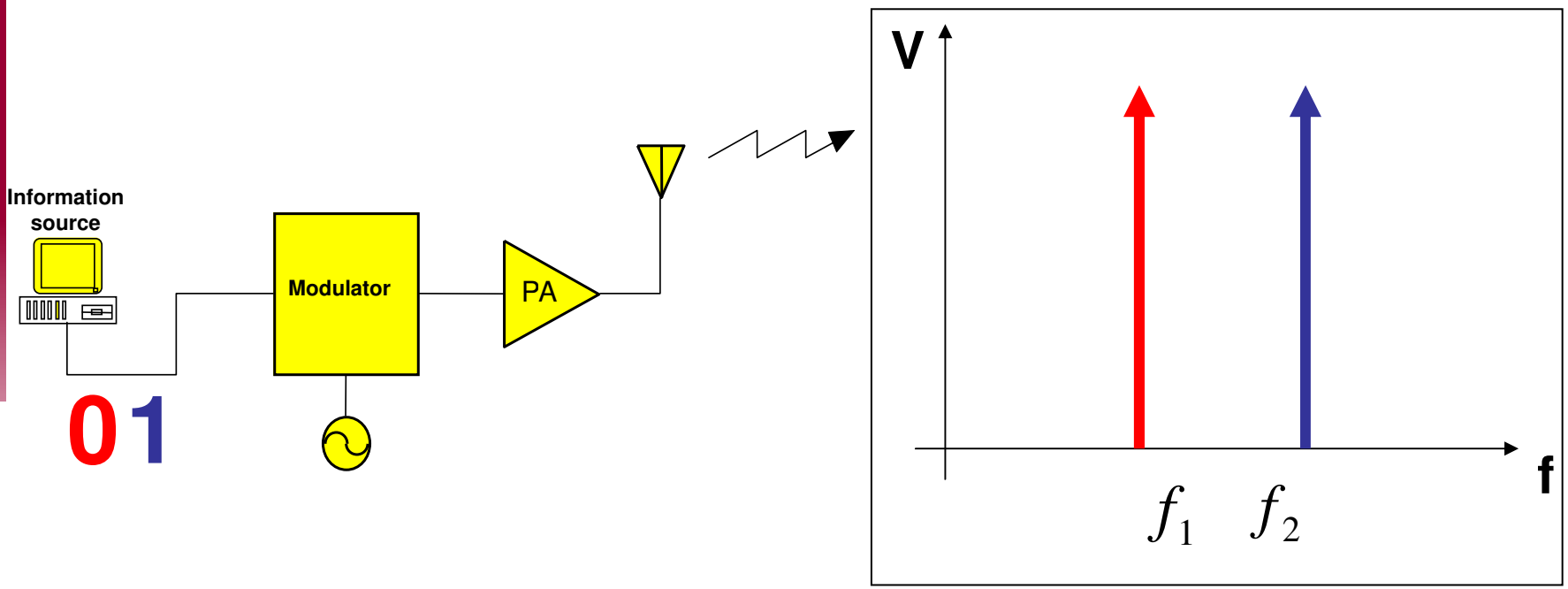


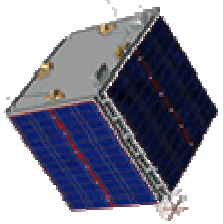
Test , developement and other issue by:

Giulio Pezzi iz4fvw@iz4fvw.net and

Ing. Gianpaolo Candini
gianpaolo.candini@unibo.it

Direct Digital Modulation (DDM)



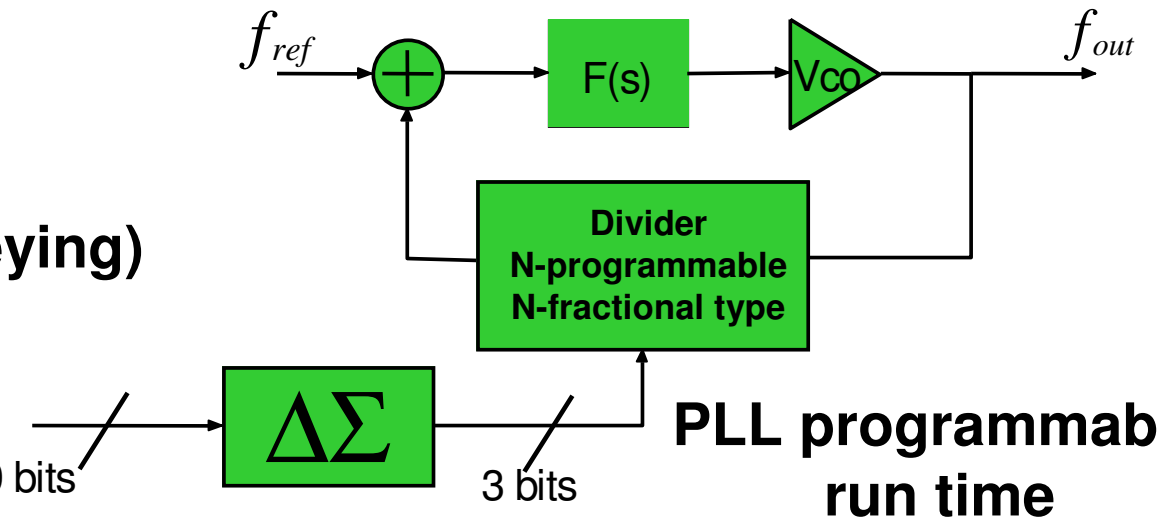


DDM

FSK (Frequency shift keying)

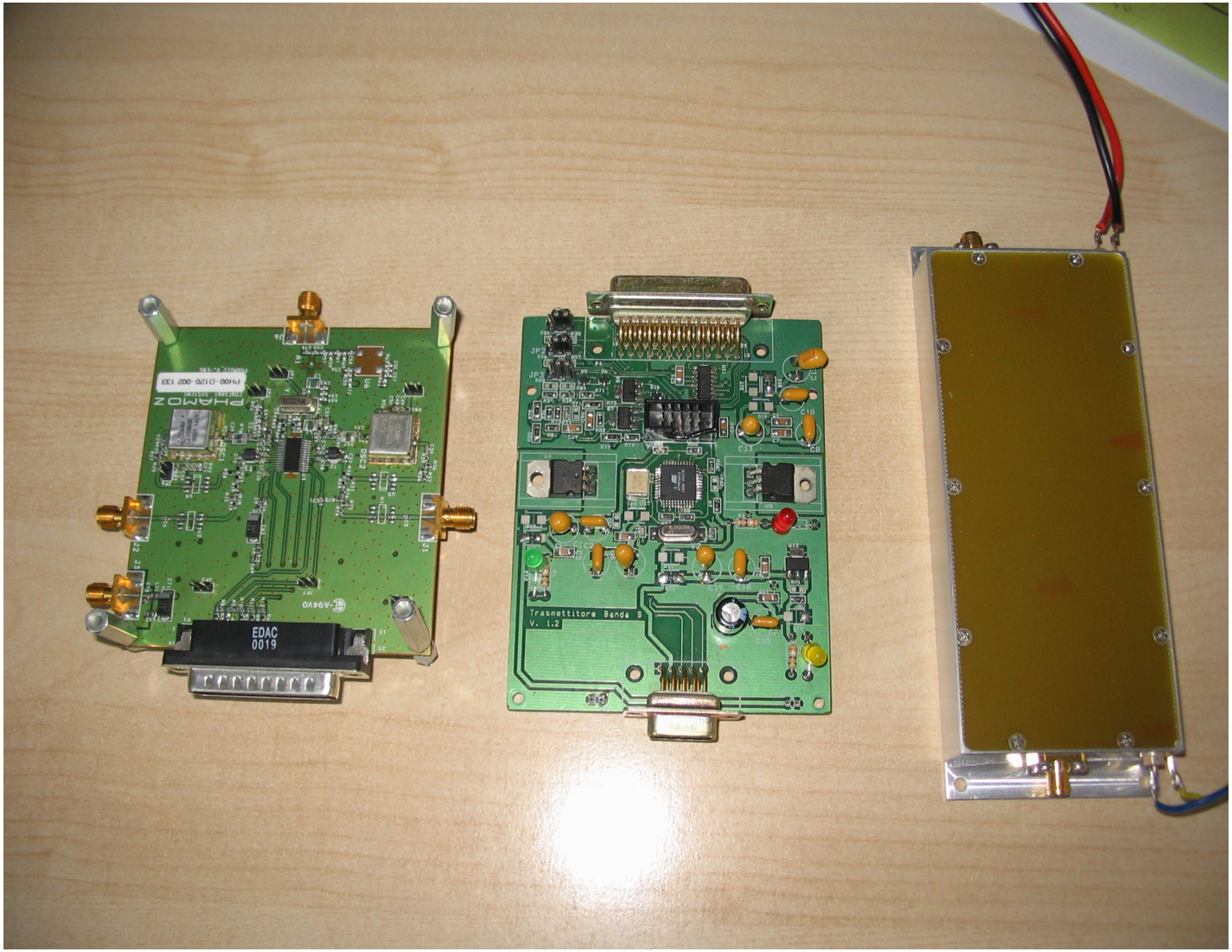
0 → f_1

1 → f_2



PLL programmable run time

S-Band satellite subsystems



FFSK 2.4 GHz Modulator, Control interface and PA

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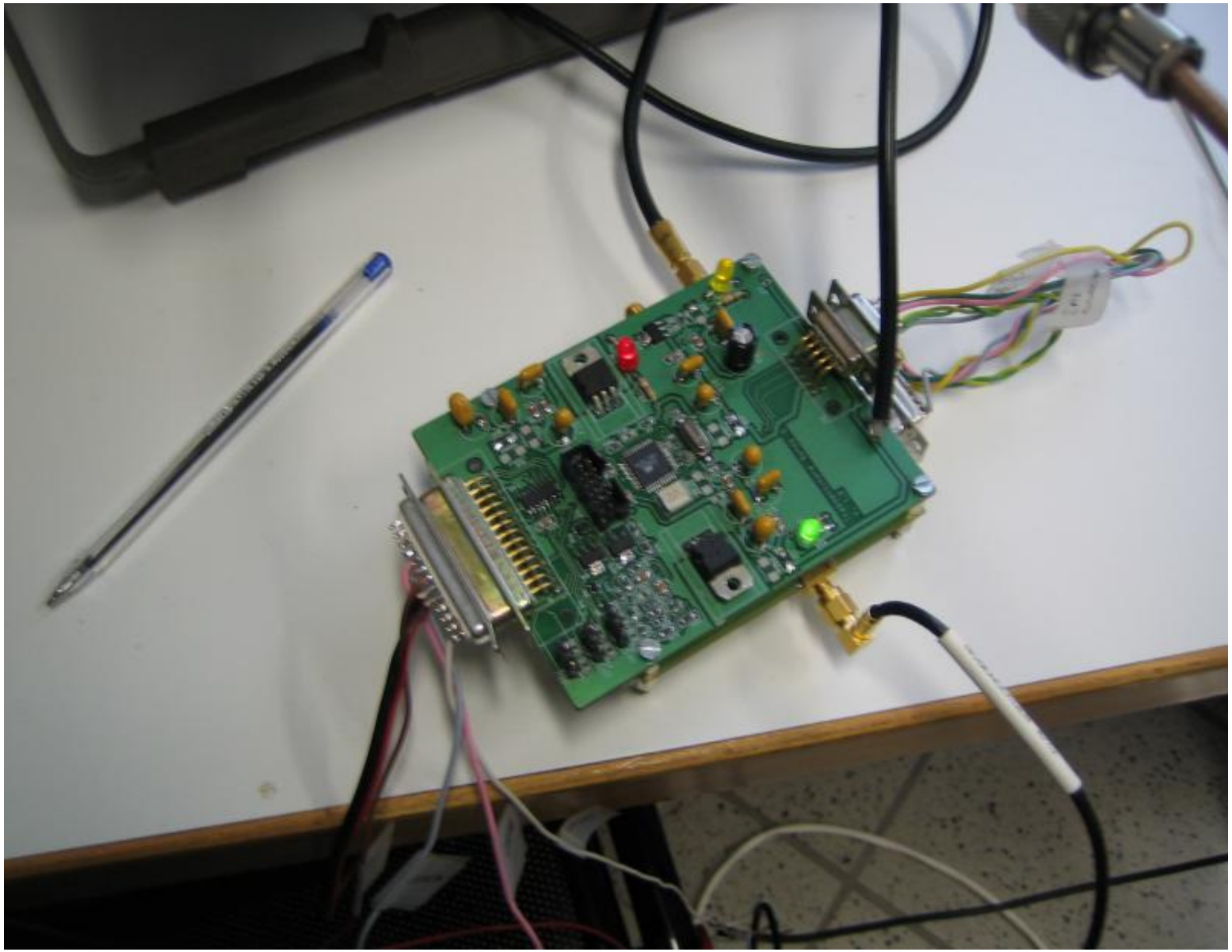
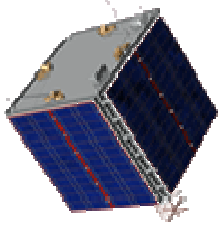
S-Band satellite subsystem test



FFSK 2.4 GHz Modulator

S-Band satellite subsystem test



Data Clock Generator

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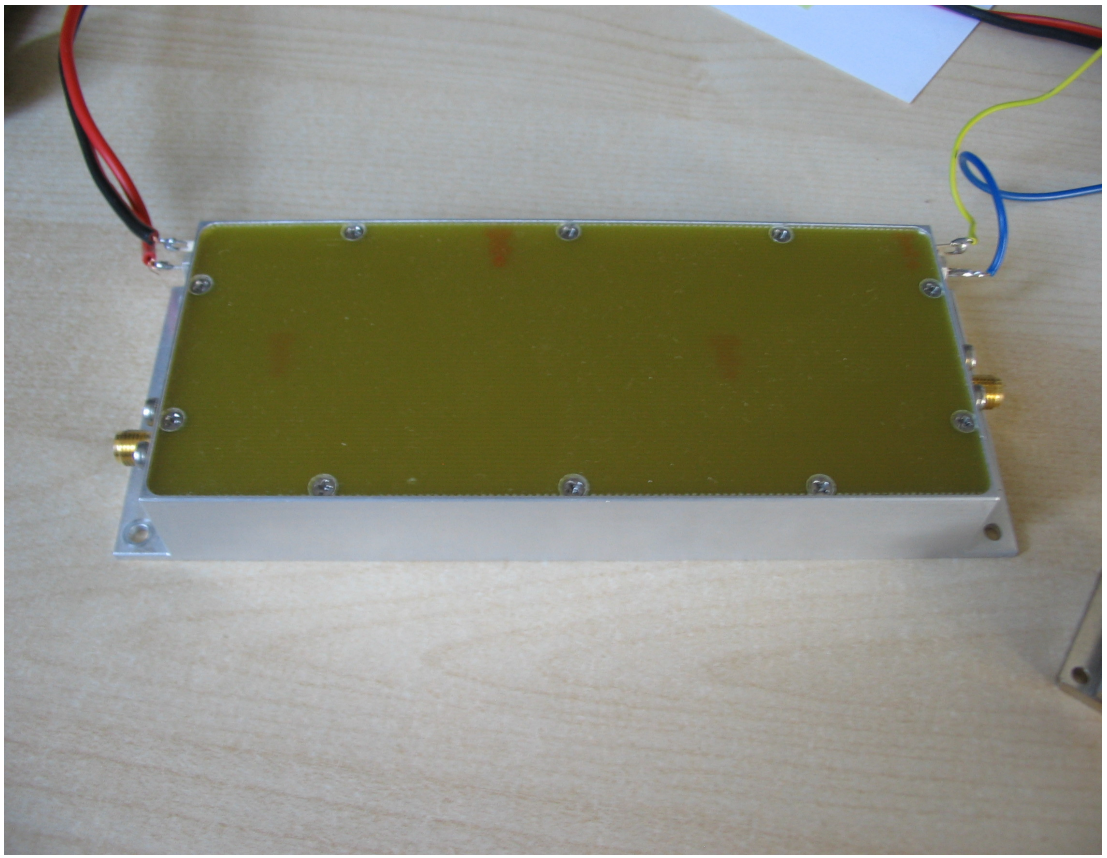
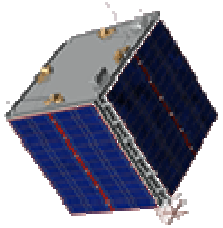
S-Band Transmission test

KU 2425-LEO2

S-band Power Amplifier





KU 2425-LEO2, Amplifier

Center frequency: 2400 MHz

Operation bandwidth: 50 MHz

Gain flatness: +/- 1dB

Nominal input power: 0 dBm +/- 0,5 dB

Input overdrive: +10 dBm

RF Input interface: SMA connector female

Input VSWR less than 1,6:1

Output power: 35 dBm, +/- 1 dB

over the operating bandwidth

Output power stability: +/- 1 dB

(ambient temperature range 10 - 30 °C)

Gain compression: at 35 dBm output power over the

whole bandwidth not less than 3 dB

Output is protected with an isolator

Harmonic levels shall be not more than -30 dBc

Output interface: SMA connector female

Output VSWR less than 1,6 :1

Noise figure: 12 dB

Operating voltage: 12 ... 13,8 V (intern linear stabilized)

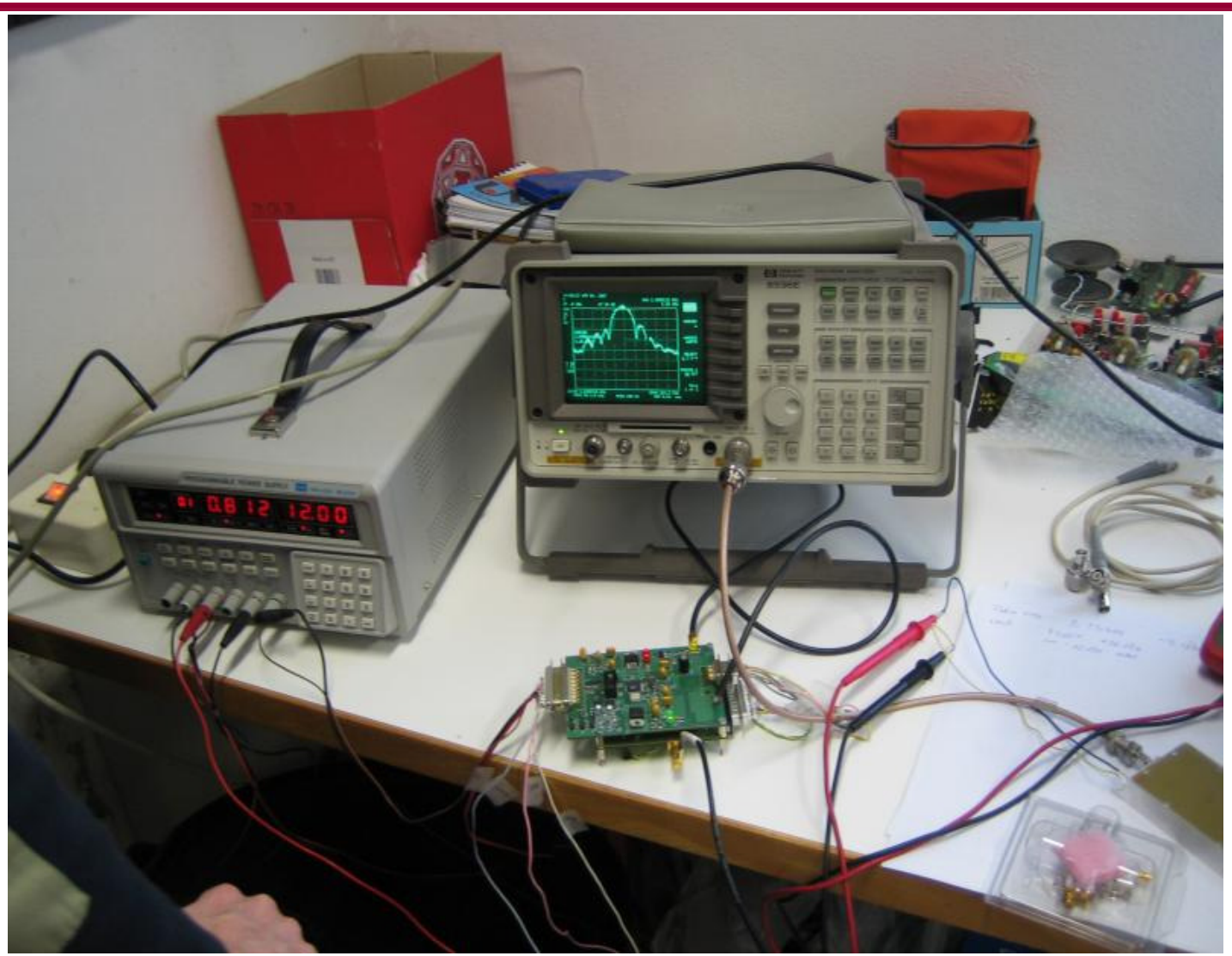
SSPA efficiency: approx. value will be around 22%.

Weight: approx. 300 g

Dimensions: 156 x 59 x 20 mm

Telemetry Interface: Monitor output and calibration curve

S-Band Transmission test



Test of modulator “on air” with no preamplifier before the power amplifier

S-Band satellite subsystem test

Voltmeter, connected to the power test point on the output of the final amplifier, showing a value relative to 0.5 watt RF

S-Band satellite subsystem test

Current absorbed without the input preamplifier

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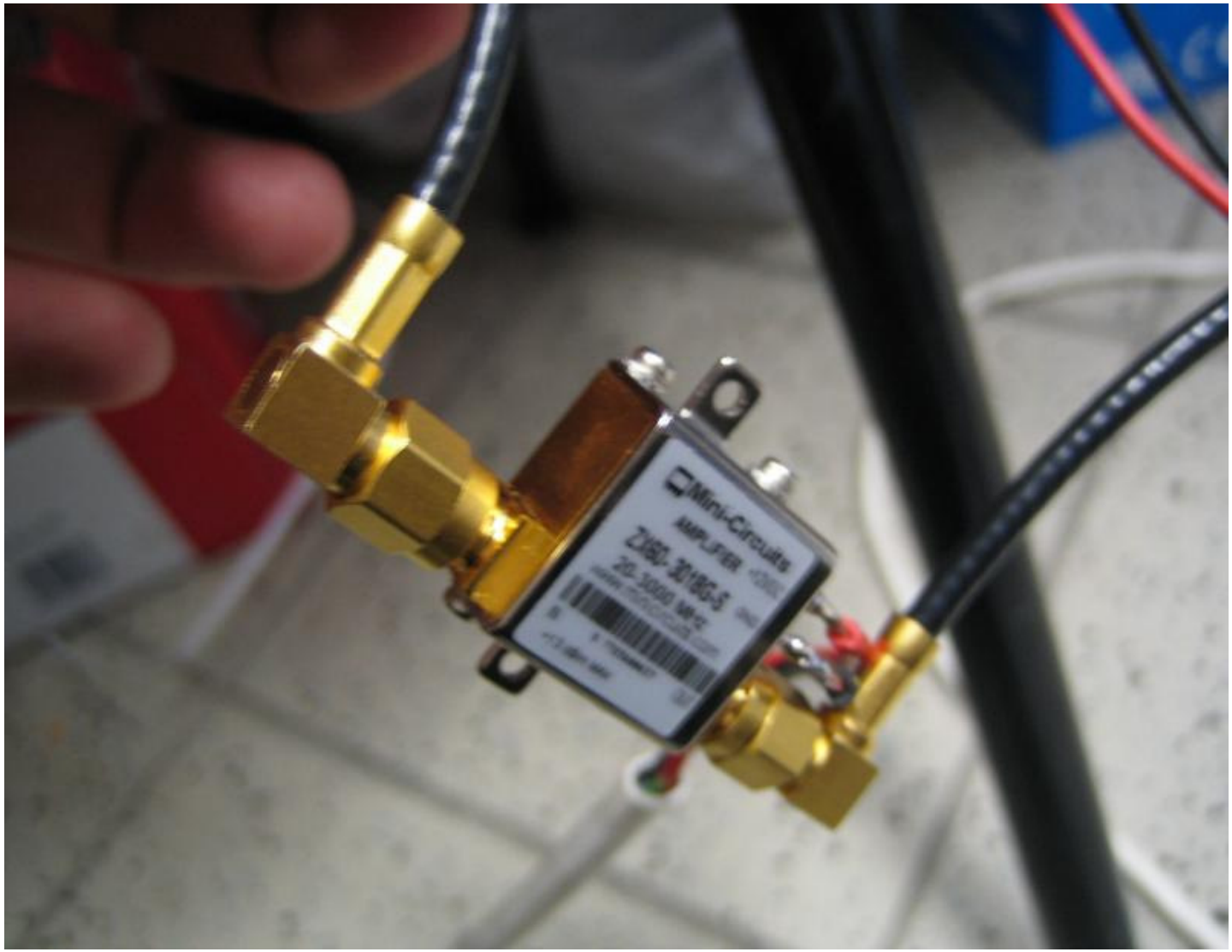
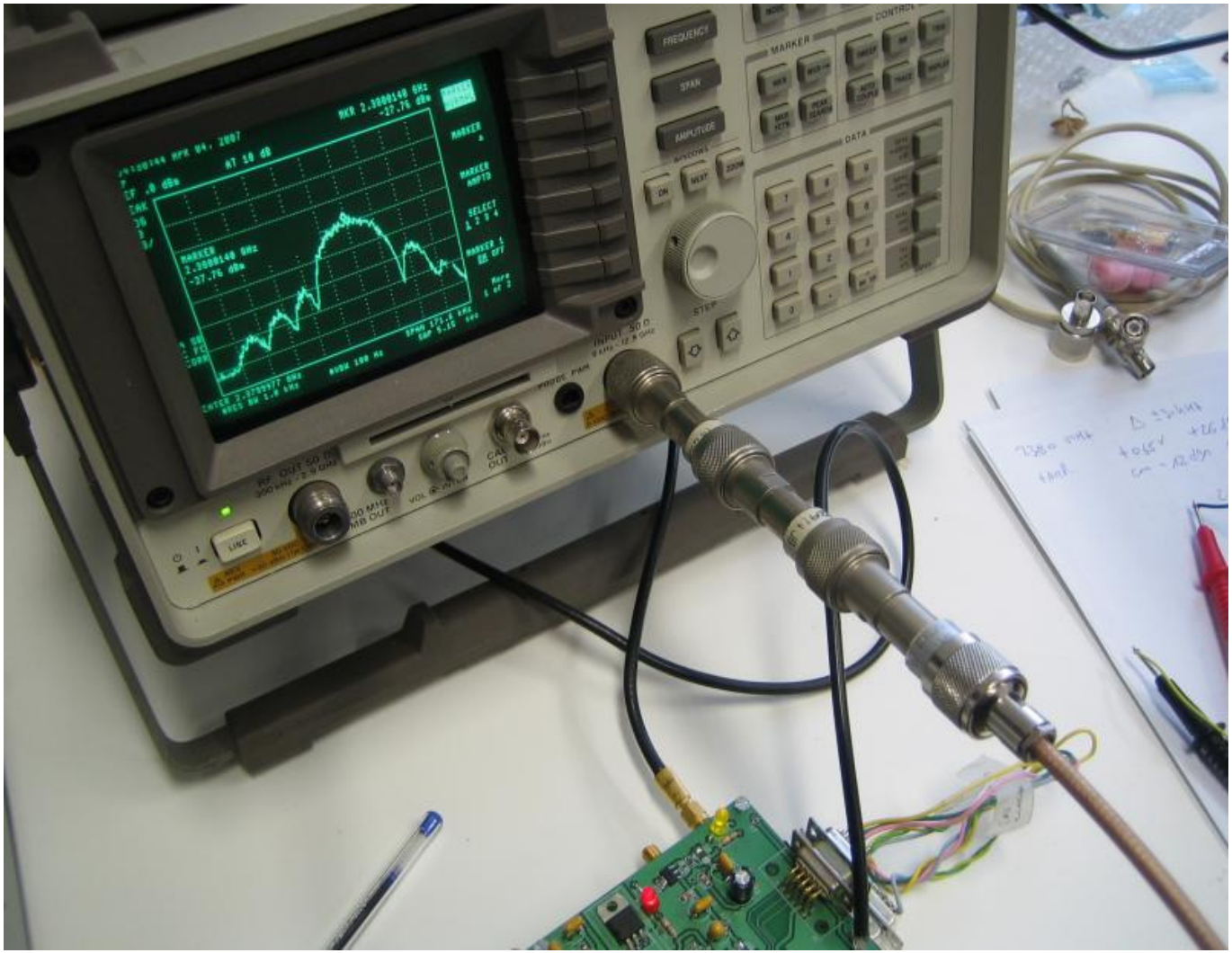
S-Band satellite subsystem test



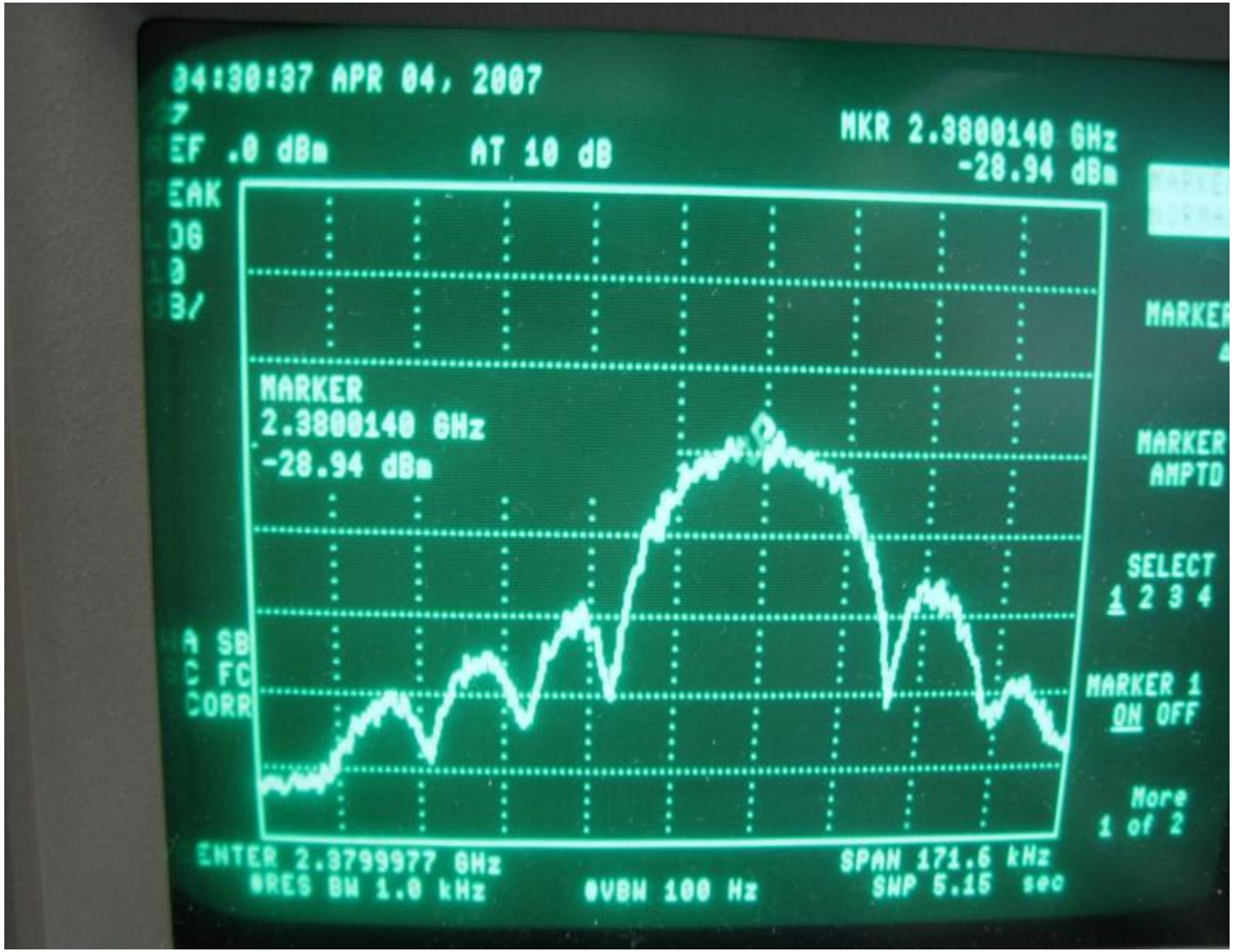
ZX60 Mini-Circuits
input preamplifier

S-Band satellite subsystem test



System test with attenuator before the spectrum analyzer input

S-Band Transmission test



Output signal with attenuators

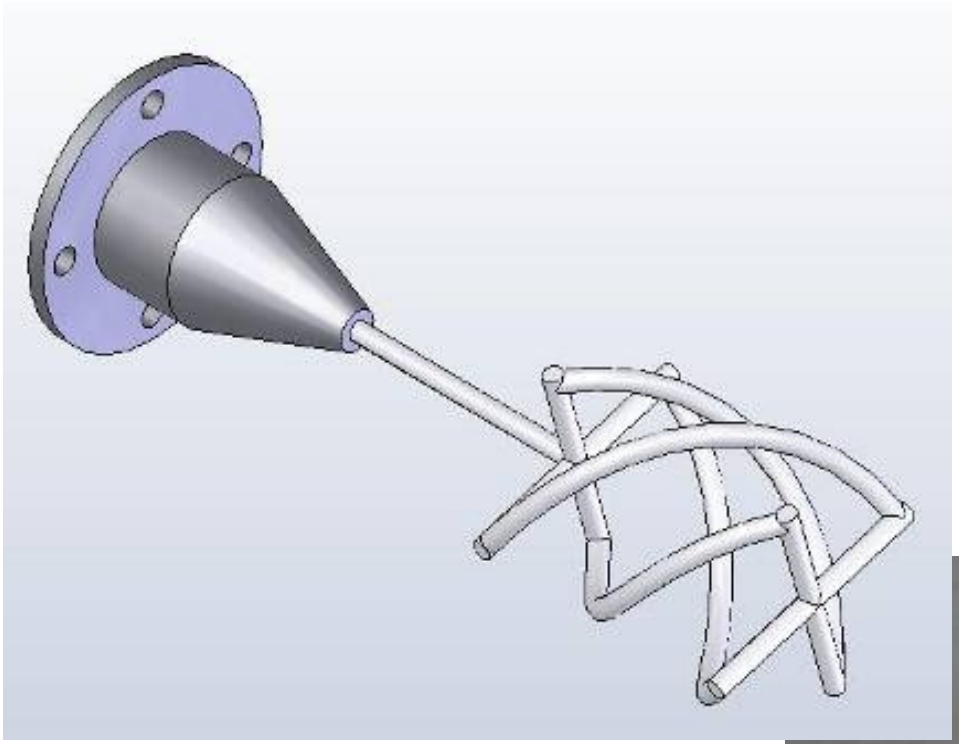
S-Band satellite subsystem test

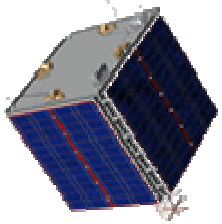
Voltage reference for an output power of 4.5 W RF (@2380 Mhz)

S-Band satellite subsystem test

Voltage and current absorbed by the system at the max output power (4.5 W RF @2380 Mhz)

S-band quadrifilar antenna

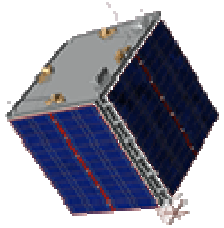


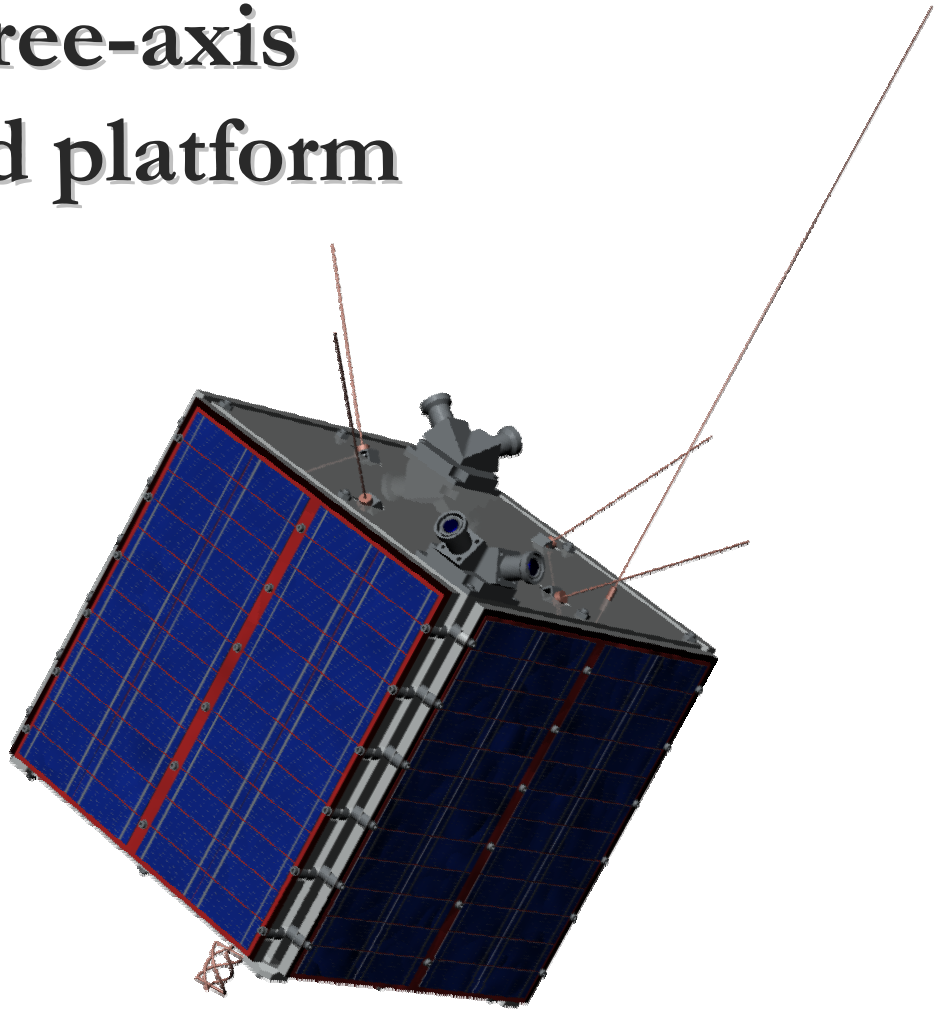


ALMASat-1 Microsatellite

ALMASat

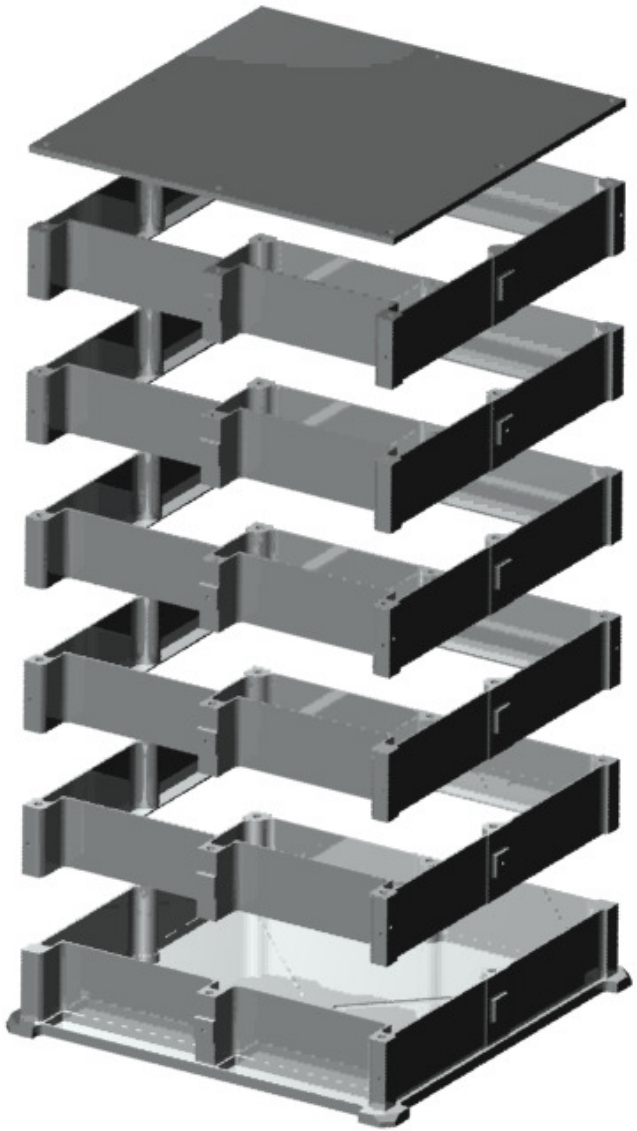
is a three-axis stabilized platform





ALMASat-1 Subsystems Layout

- Final layout of S/C subsystems:



6 UHF-VHF Radio RX-TX

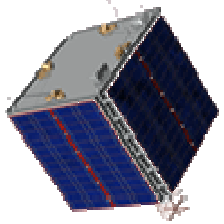
5 Modem + Telemetry board

4 Battery packs

3 Micropropulsion System

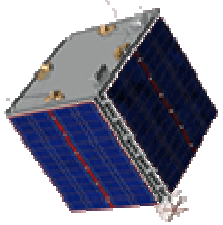
2 ADCS

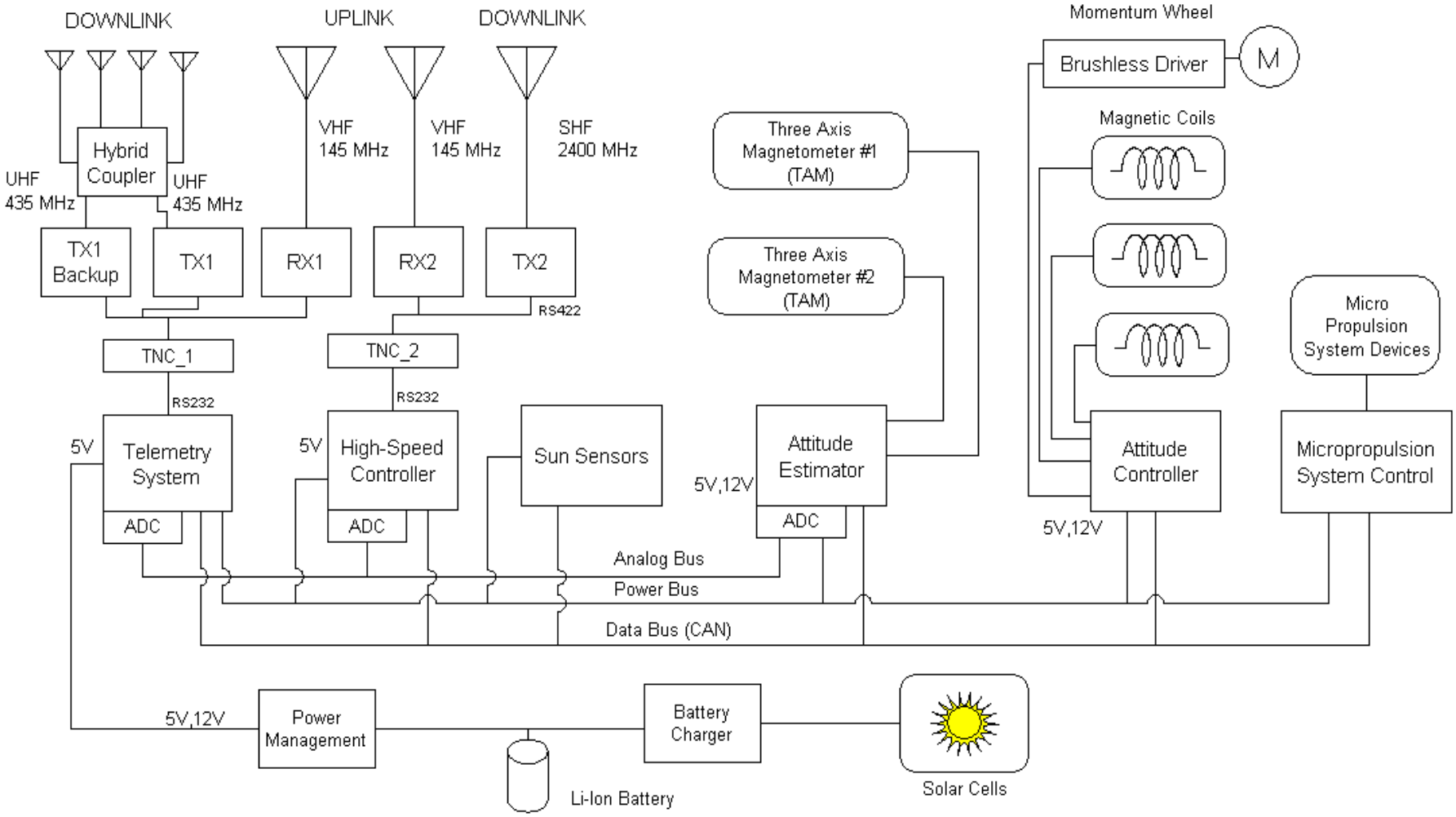
1 Power board + S-band TX



ALMASat Alma Mater Satellite

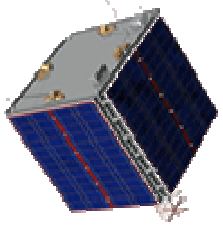
ALMASat-1 Electronics and RF block diagram





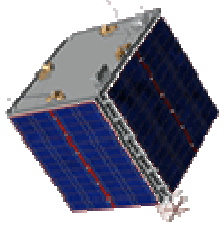
ALMASat-1: Launch Options (1/2)

- **ALMASat-1** can be launched by a converted SS-19 intercontinental missile from the **Baikonour Cosmodrome** (Kazahstan)
- The **DNEPR** program was started by a Russian-Ukrainian collaboration in 1999 focused on the civilian conversion of former nuclear weapons
- **University of Bologna** has a memorandum of understanding with Kosmotras



ALMASat-1: Launch Options (2/2)

- **ALMASat-1** can also be launched by the new small European launcher **VEGA** from **Kourou** (French Guyana)
- The **VEGA** missile has its maiden flight scheduled for 2008, fully compatible with our schedule
- **University of Bologna** has undertaken preliminary contacts with **ESA** for a lift to space on the 1st VEGA flight



ALMASat Alma Mater Satellite

The End …

73 from ..

Giulio Pezzi

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